Name: ____________________ Student Number 930772

2
0
1
3
10
8
8
7
8
7
3
0
—
51

CMPT220 Midterm Examination
March 12, 2002
Closed Book, 1 Letter Size sheet of notes allowed
Answer all questions on this examination paper
75 MARKS

1. *(4 marks)* When implementing logic functions using CMOS technology, what is the purpose of the pull-up network? The pull-down network?

The pull-up network must be able to attain V_{DD} when necessary and the pull-down network must be the opposite of the pull-up network and must get V_G when necessary.
The PUN is also made up of PMOS transistors while the PDN is made up of NMOS transistors.

2

2. *(4 marks)* What is the major problem associated with rapidly performing addition or subtraction with larger numbers? What was the solution?

The problem is the loss of precision in the lower-end bits.

0

3. *(4 marks)* What is "high-impedance" and why is it important?

High-impedance is a state in a wire usually represented as Z and it is important because it doesn't matter if the output is a 1 or a 0 and it helps solve the fan-out problem.

1

4. *(4 marks)* What are two uses for a multiplexer?

One use is to determine which inputs should go on in a circuit depending on what the control signals are set at.
Another use is to determine what value to return from a look-up table.

3

Name: _____ Student Number 430772

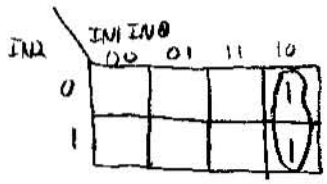
5. *(10 marks)* Given the following table of inputs versus outputs for a logic circuit, answer the following questions using variables of the form IN*x* and OUT*x* to denote the x^{th} bit and where x = 0 represents the lowest order bit.

Input	0	1	3	2	6	7	5	4
Output	0	1	2	4	4	2	1	0

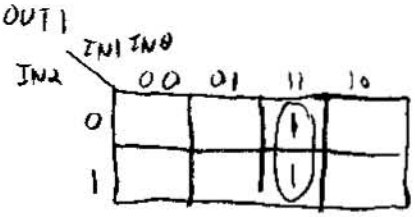
a) Draw the Karnaugh Maps for each output bit, clearly identifying the inputs and outputs.
b) Minimize each K-Map using SOP form and clearly identify your solution. **Please do not attempt to optimize your solution beyond the K-Map derivation!**

IN2	IN1	IN0	OUT2	OUT1	OUT0
0	0	0	0	0	0
0	0	1	0	0	1
0	1	0	1	0	0
0	1	1	0	1	0
1	0	0	0	0	0
1	0	1	0	0	1
1	1	0	1	0	0
1	1	1	0	1	0

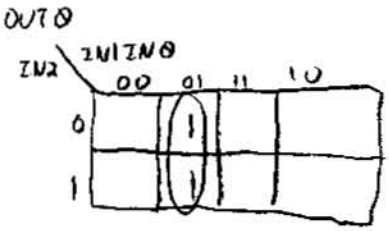
a) OUT2



OUT1



OUT0



b) $OUT2 = IN1\,\overline{IN0}$

$OUT1 = IN1\,IN0$

$OUT0 = \overline{IN1}\,IN0$

10

6. *(10 marks)* Write the Entity and Architecture VHDL code for the logic function
F(x2, x1, x0) = Σm(1, 2, 4, 7)

```
LIBRARY ieee;
USE ieee_std_logic_1164.all;

ENTITY testquestion IS
    PORT (x2, x1, x0 : IN BIT;
          F          : OUT BIT);
END testquestion

ARCHITECTURE LogicFunc OF testquestion IS
BEGIN
    F <= (x2 AND NOT x1 AND NOT x0) OR (NOT x2 AND NOT x1 AND x0) OR
         (x2 AND x1 AND x0) OR (NOT x2 AND x1 AND NOT x0);
END LogicFunc;
```

(8)

Name: _____ Student Number 930772

7. *(8 marks)* Express the following K-maps as logic functions of the required form.

a) F(x4, x3, x2, x1) = $\bar{x3}\bar{x2}\bar{x1} + x4\bar{x3}x1 + x3\bar{x2}x1 + x4x3x1 + \bar{x4}x3x2\bar{x1}$ Sum of Products Form

F

x4x3 \ x2x1	00	01	11	10
00	1	0	0	0
01	0	1	0	1
11	0	1	1	0
10	1	0	0	1

b) G(x1, x2, x3, x4) = $(x2 + x4)(x1 + \bar{x3})(\bar{x2} + \bar{x4})$ Product of Sums Form

G

x1x2 \ x3x4	00	01	11	10
00	0	1	1	0
01	0	D	D	0
11	1	0	0	1
10	0	1	1	0

8

8. *(4 marks)* What is the difference between a binary encoder and a binary decoder?

A binary decoder has n inputs and produces 2^n outputs which are one-hot encoded or only one of the outputs is 1. A binary encoder has 2^n inputs which are one-hot encoded and produces n outputs.

4

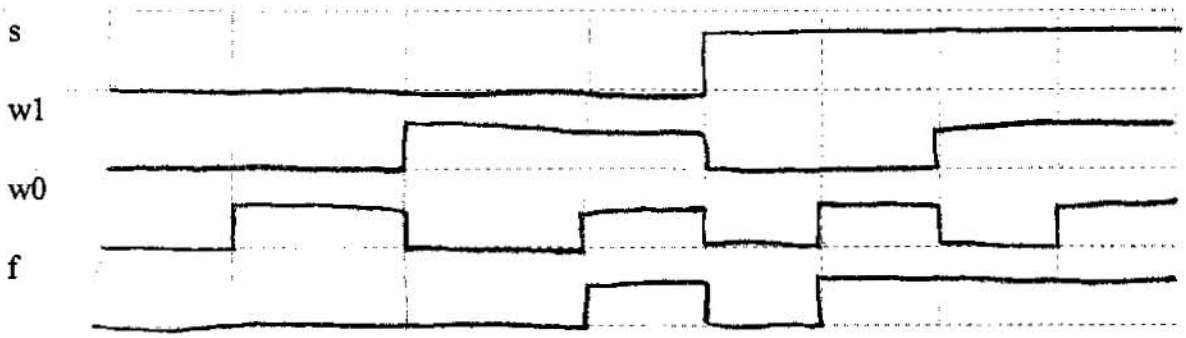
Name: _____ Student Number 970772

9. *(8 marks)* Given the following VHDL code, draw the timing diagram for the resulting circuit as if you were the Max+plus II development environment.

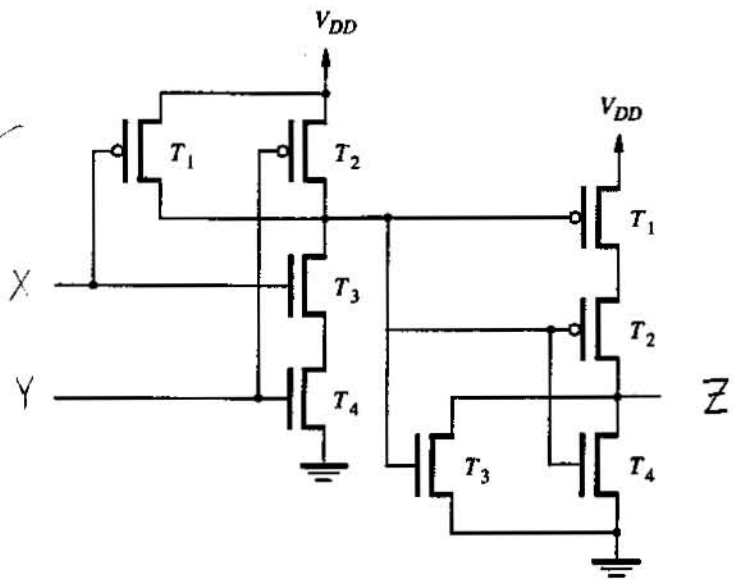
```
LIBRARY ieee;
USE ieee.std_logic_1164.all;

ENTITY midterm IS
        PORT (      w1, w0, s      : IN    STD_LOGIC;
                    f              : OUT STD_LOGIC);
END midterm;

ARCHITECTURE behavior OF midterm IS
BEGIN
        WITH s SELECT
                f <=    (w1 AND w0) WHEN '0'
                        (w1 OR w0) WHEN OTHERS;
END behavior;
```

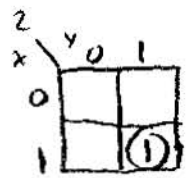


10. *(4 marks)* Express the logic function implemented by the following CMOS circuit in Sum Of Products form.



AND function

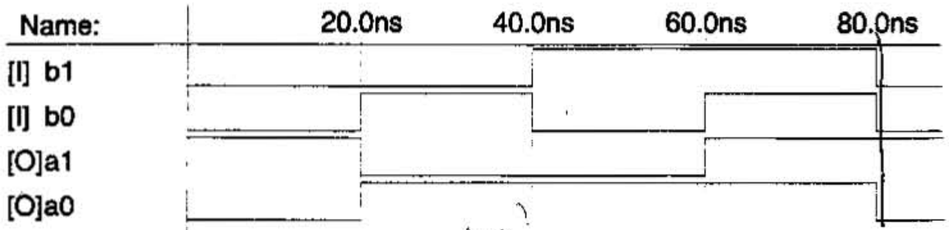
x	y	z
0	0	0
0	1	0
1	0	0
1	1	1



$z = xy$

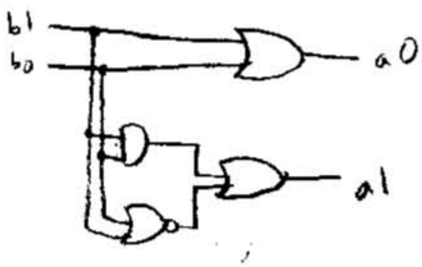
Name: ______________________ Student Number 930772

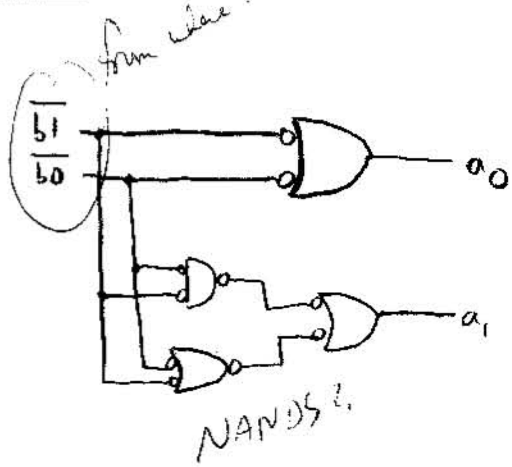
11. *(9 marks)* Analyze the following timing diagram to determine the logic function that it represents. Clearly state the logic function and design a circuit that implements the logic function using NAND gates only.



b1	b0	a1	a0
0	0	1	0
0	1	0	1
1	0	0	1
1	1	1	1
		XNOR	OR

a1 = EXCLUSIVE NOR
a0 = OR





(3)

12. *(6 marks)* What is *the* distinguishing characteristic for each of combinational, sequential, and synchronous systems.

A sequential system is a system where one thing is done and the next thing starts as soon as the first thing finishes.

A combinational system is one where some parts can be done at the same time to speed up the system.

A synchronous system is where everything is done at the same time.